Monitoring of Chlorinated Disinfection By-Products in Drinking Water: Approach Based on Differential Spectroscopy

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Biographical Sketch

Gregory Korshin is an associate professor with the Department of Civil and Environmental Engineering, University of Washington. He received his Master's and Ph.D. degrees in spectroscopy and physical chemistry, respectively, at Kazan State University and Kazan Technological University (both in Russia). He immigrated to the United States in 1991 and has worked at University of Washington since then. His research has been focused on the development of novel techniques to predicts the formation of halogenated compounds in drinking water, investigation of the relevant chemical mechanisms, corrosion and metal release in drinking water, development of electrochemical methods for treatment of drinking water and wastewater and development of novel on-line methods to monitor water quality.

Mark Benjamin is Osberg professor with the Department of Civil and Environmental Engineering, University of Washington. He received his Ph.D. degree at Stanford University. Mark Benjamin is a well-known expert in physico-chemical methods for water treatment. He has developed novel adsorbents to remove heavy metals and organic contaminants, has lead research on arsenic removal and has published, among his many other publications, a well-known textbook "Aquatic Chemistry".

Abstract

Disinfection of drinking water with chlorine or chloramine causes a variety of chlorinated and brominated disinfection by-products (DBP) to be formed. The identified DBPs are predominated by chloroform and haloacetic acids, but > 50% of DBPs have not been assigned to individual species. Drinking water utilities must monitor their water for the occurrence and levels of the major identified DBPs, but high costs of relevant analyses ($100 to $300 per sample) and significant turnaround time limit their ability to carry out continuous and/or multi-site monitoring.

Our research has shown that differential spectroscopy has a potential to dramatically simplify and improve the ability of water utilities to monitor the quality of their water. In that method, the main parameter is the change of absorbance at a preset wavelength (typically, 270 nm) caused by chlorine or chloramine. The magnitude of differential absorbance is very strongly correlated with the formation of individual DBPs that include both their major (chloroform and haloacetic acids) and minor contributing species (chloral hydrate, haloketones and haloacetonitriles) whose health effects have not yet been ascertained. Another highly attractive feature of this monitoring approach is based on the linearity and "portability" of the correlation between the total concentration of all DBPs and the values of differential absorbance. In fact, the correlations between DBPs concentrations and the magnitude of differential absorbance are defined by the very nature of halogenation processes and therefore are observed in a wide variety of water qualities. The data for waters ranging from high quality low-organic, low-bromide sources to much more difficult to control high-organic waters will be compared.

The major practical significance of the differential absorbance approach is defined by its ability to provide on-line monitoring of water quality for only a small fraction of costs normally associated with analytical activities. The requirements to relevant instrumentation and the relevance of the approach to the practices of water quality monitoring (not necessarily limited to halogenated DBPs) will be outlined in the presentation.